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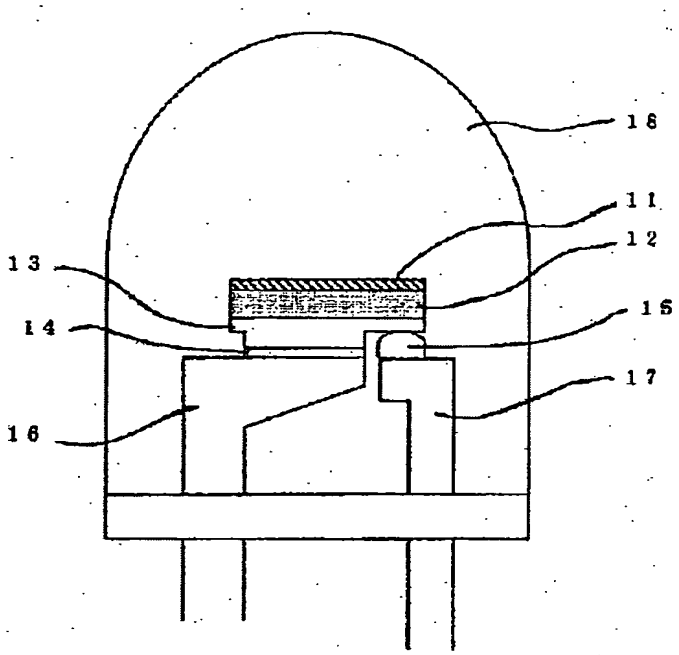
TITLE : WHITE LIGHT-EMITTING ELEMENT AND MANUFACTURING METHOD THEREOF



ABSTRACT : PROBLEM TO BE SOLVED: To overcome the problem such that a conventional white LED manufactured by coating a YAG phosphor on a light-emitting surface of a blue LED or dispersing it into a sealing resin is insufficient in brightness to be used for lighting.

SOLUTION: Related to the white light-emitting element, the light emitting part of the blue LED comprising group III nitride semiconductor is provided with an oxynitride glass phosphor layer to which a luminescent center is added. As the oxynitride glass, especially, a Ca-Al-Si-O-N oxynitride glass to which Eu2+ ion is added as the luminescent center is used.

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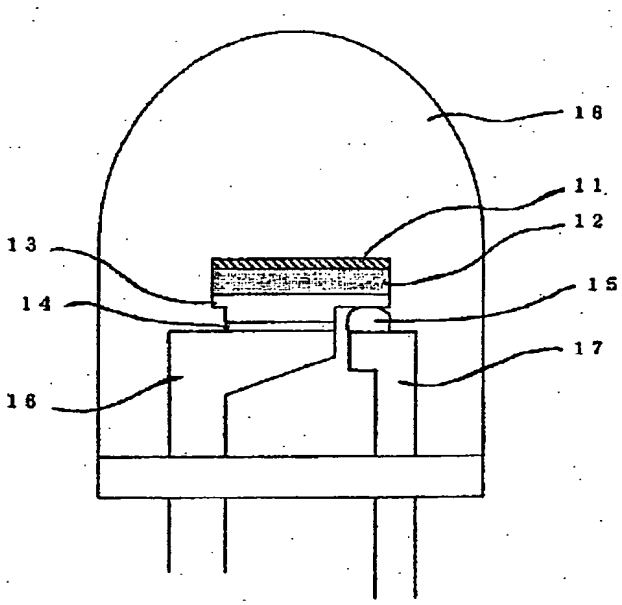
(54)【発明の名称】　白色発光素子およびその製造方法

(57)【要約】
【課題】従来のＹＡＧ系蛍光体を青色ＬＥＤの発光面に塗布または封止樹脂中に分散させて作製した白色ＬＥＤは、照明用として使用するには明るさが不十分である点を改善する。
【解決手段】本発明の白色発光素子は、ＩＩＩ族窒化物半導体を用いた青色ＬＥＤの光放出部に、発光中心を添加したオキシ窒化物ガラス蛍光体層を有する構造とする。オキシ窒化物ガラスとして、特に発光中心としてEu^{2+}イオンを添加したＣａ－Ａｌ－Ｓｉ－Ｏ－Ｎ系オキシ窒化物ガラスを用いる。



【特許請求の範囲】
【請求項１】透明な基板上に形成したＩＩＩ族窒化物半導体よりなる発光素子と、発光素子から放出される光の一部を発光素子より放出される光より波長の長い光に変換するガラス蛍光体層とを有するフリップチップ型発光素子において、少なくとも、透明な基板の上でありかつＩＩＩ族窒化物半導体を積層した基板の面と反対の面の上に、発光中心を添加したオキシ窒化物ガラス蛍光体層を有する事を特徴とする白色発光素子。
【請求項２】オキシ窒化物ガラスが、発光中心としてEu^{2+}イオンを添加したＣａ－Ａｌ－Ｓｉ－Ｏ－Ｎ系オキシ窒化物ガラスである事を特徴とする請求項１に記載の白色発光素子。
【請求項３】発光中心を添加したオキシ窒化物ガラス蛍光体層を高周波スパッタ法により形成する事を特徴とする請求項１または２に記載の白色発光素子の製造方法。
【請求項４】発光中心を添加したオキシ窒化物ガラス蛍光体層を樹脂中に分散させたオキシ窒化物ガラス蛍光体の塗布により形成する事を特徴とする請求項１または２に記載の白色発光素子の製造方法。
【請求項５】基板上に形成したＩＩＩ族窒化物半導体上に透明電極を有する発光素子と、発光素子から放出される光の一部を発光素子より放出される光より波長の長い光に変換するガラス蛍光体層とを有する発光素子において、少なくとも、透明電極面の上に発光中心を添加したオキシ窒化物ガラス蛍光体層を有する事を特徴とする白色発光素子。
【請求項６】オキシ窒化物ガラスが、発光中心としてEu^{2+}イオンを添加したＣａ－Ａｌ－Ｓｉ－Ｏ－Ｎ系オキシ窒化物ガラスである事を特徴とする請求項５に記載の白色発光素子。
【請求項７】発光中心を添加したオキシ窒化物ガラス蛍光体層を高周波スパッタ法により形成する事を特徴とする請求項５または６に記載の白色発光素子の製造方法。
【請求項８】発光中心を添加したオキシ窒化物ガラス蛍光体層を樹脂中に分散させたオキシ窒化物ガラス蛍光体の塗布により形成する事を特徴とする請求項５または６に記載の白色発光素子の製造方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は白色発光素子とその製造方法に係わり、特にＩＩＩ族窒化物半導体（一般式：ＡｌＧａＩｎＮ）を用いた発光素子とガラス蛍光体とを組み合わせた白色発光素子とその製造方法に関する。
【０００２】
【従来の技術】白色の発光ダイオードとしては、$(Y、Gd)_3(Al、Ga)_5O_{12}$の組成式で知られるＹＡＧ系酸化物母体格子中にＣｅをドープした蛍光体（ＹＡＧ系蛍光体）を、ＩＩＩ族窒化物半導体を用いた青色発光ダイオード（青色ＬＥＤ）を包囲する封止樹脂中に分散させたもの（特許番号２９００９２８、特許番号２９９８６９６、特許番号２９２７２７９）や、非粒子状性の蛍光体層として青色ＬＥＤ上に成膜したもの（特開平１１－４６０１５号公報）が知られている。これらはディスプレイのバックライト、照光式操作スイッチ、ＬＥＤ表示器等に使用されている。
【０００３】
【発明が解決しようとする課題】ＩＩＩ族窒化物半導体を用いた高輝度の青色ＬＥＤが実用化した事から、青色ＬＥＤを白色照明に利用しようとする試みが進められている。しかし、従来の青色ＬＥＤチップにＹＡＧ系蛍光体を塗布して作られる白色ＬＥＤでは、照明用としては明るさが不十分であった。ＹＡＧ系蛍光体は４００ｎｍより長波長の光に対し励起効率が悪いからである。ちなみに照明用の白色とは太陽光色、蛍光灯色、電球色等、照明に使われている色全てを指す。本発明は、照明用として十分な明るさを有する、ＩＩＩ族窒化物半導体を用いた発光素子とガラス蛍光体とを組み合わせた新たな白色発光素子とその製造方法を提供することを目的とする。
【０００４】
【課題を解決するための手段】本発明は、（１）透明な基板上に形成したＩＩＩ族窒化物半導体よりなる発光素子と、発光素子から放出される光の一部を発光素子より放出される光より波長の長い光に変換するガラス蛍光体層とを有するフリップチップ型発光素子において、少なくとも、透明な基板の上でありかつＩＩＩ族窒化物半導体を積層した基板の面と反対の面の上に、発光中心を添加したオキシ窒化物ガラス蛍光体層を有する事を特徴とする白色発光素子、（２）オキシ窒化物ガラスが、発光中心としてEu^{2+}イオンを添加したＣａ－Ａｌ－Ｓｉ－Ｏ－Ｎ系オキシ窒化物ガラスである事を特徴とする（１）に記載の白色発光素子、である。
【０００５】また本発明は、（３）発光中心を添加したオキシ窒化物ガラス蛍光体層を高周波スパッタ法により形成する事を特徴とする（１）または（２）に記載の白色発光素子の製造方法、（４）発光中心を添加したオキシ窒化物ガラス蛍光体層を樹脂中に分散させたオキシ窒化物ガラス蛍光体の塗布により形成する事を特徴とする（１）または（２）に記載の白色発光素子の製造方法、である。
【０００６】また本発明は、（５）基板上に形成したＩＩＩ族窒化物半導体上に透明電極を有する発光素子と、発光素子から放出される光の一部を発光素子より放出される光より波長の長い光に変換するガラス蛍光体層とを有する発光素子において、少なくとも、透明電極面の上に発光中心を添加したオキシ窒化物ガラス蛍光体層を有する事を特徴とする白色発光素子、（６）オキシ窒化物ガラスが、発光中心としてEu^{2+}イオンを添加したＣａ

－Ａｌ－Ｓｉ－Ｏ－Ｎ系オキシ窒化物ガラスである事を特徴とする（５）に記載の白色発光素子、である。

【０００７】また本発明は、（７）発光中心を添加したオキシ窒化物ガラス蛍光体層を高周波スパッタ法により形成する事を特徴とする（５）または（６）に記載の白色発光素子の製造方法、（８）発光中心を添加したオキシ窒化物ガラス蛍光体層を樹脂中に分散させたオキシ窒化物ガラス蛍光体の塗布により形成する事を特徴とする（５）または（６）に記載の白色発光素子の製造方法、である。

【０００８】

【発明の実施の形態】新しい蛍光体材料として、オキシ窒化物ガラスを母体原料とした蛍光体が報告されている（固体物理Ｖｏｌ．３５、Ｎｏ．６（２０００））。オキシ窒化物ガラスを母体とした蛍光体は励起スペクトルのピークが３５０ｎｍ～５００ｎｍであり、ＩＩＩ族窒化物半導体を用いた青色ＬＥＤ（発光波長の中心が４５０ｎｍ～５２０ｎｍである。）で最も効率良く蛍光体を励起する事ができる。そこで本発明者はオキシ窒化物ガラスを母体材料とした蛍光体をＩＩＩ族窒化物半導体を用いた青色ＬＥＤと組み合わせることで高効率、高出力の白色発光素子を開発した。

【０００９】オキシ窒化物ガラスとしては、Ｓｉ－Ｏ－Ｎ、Ｍｇ－Ｓｉ－Ｏ－Ｎ、Ａｌ－Ｓｉ－Ｏ－Ｎ、Ｎｄ－Ａｌ－Ｓｉ－Ｏ－Ｎ、Ｙ－Ａｌ－Ｓｉ－Ｏ－Ｎ、Ｃａ－Ａｌ－Ｓｉ－Ｏ－Ｎ、Ｍｇ－Ａｌ－Ｓｉ－Ｏ－Ｎ、Ｎａ－Ｓｉ－Ｏ－Ｎ、Ｎａ－Ｃａ－Ｓｉ－Ｏ－Ｎ、Ｌｉ－Ｃａ－Ａｌ－Ｓｉ－Ｏ－Ｎ、Ｎａ－Ｂ－Ｓｉ－Ｏ－Ｎ、Ｎａ－Ｂａ－Ｂ－Ａｌ－Ｓｉ－Ｏ－Ｎ、Ｂａ－Ａｌ－Ｓｉ－Ｏ－Ｎ、Ｎａ－Ｂ－Ｏ－Ｎ、Ｌｉ－Ｐ－Ｏ－Ｎ、Ｎａ－Ｐ－Ｏ－Ｎなどの系が知られている。

【００１０】これらの系の中で本発明に使われる母体としては、Ｃａ－Ａｌ－Ｓｉ－Ｏ－Ｎ系オキシ窒化物ガラスが特に望ましい。Ｃａ－Ａｌ－Ｓｉ－Ｏ－Ｎ系オキシ窒化物ガラスの組成としてはＣａＯ：２０～５０モル％、Al_2O_3：０．１～３０モル％、ＳｉＯ：２５～６０モル％、ＡｌＮ：５～５０モル％、希土類酸化物または遷移金属酸化物：０．１～２０モル％で５成分の合計が１００モル％とするのが好ましい。更に望ましくは窒素含有量が１５ｗｔ％以下である。増感剤として他の希土類元素イオンを希土類酸化物として蛍光ガラス中に０．１～１０モル％の含有量で共賦活剤として含む事も望ましい。

【００１１】添加される発光中心は、Eu^{2+}、Eu^{3+}、Ce^{3+}、Tb^{3+}などの希土類イオンやCr^{3+}、Mn^{2+}などの遷移金属イオンが好ましく、このうち特にEu^{2+}が好ましい。これら発光中心イオンは、母体材料のCa^{2+}イオンに置き換わる形で固体中に取り込まれている。

【００１２】発光中心を添加したオキシ窒化物ガラス蛍光体層をＬＥＤチップに作製する上で不可欠なのがオキシ窒化物ガラスの成膜技術である。本発明者は高周波スパッタ法を適用する事で、ＩＩＩ族窒化物半導体を用いた青色ＬＥＤ用ウエハの基板裏面、あるいはエピタキシャル層表面に、発光中心を添加したオキシ窒化物ガラス蛍光体層を成膜させる事に成功した。高周波スパッタ法に加え、オキシ窒化物ガラス蛍光体の粉を樹脂中に分散させた物を塗布する事でも成膜が可能である。バインダーとなる樹脂は（メタ）アクリル酸系樹脂や、エポキシ、ウレタン架橋、ＵＶ硬化などの架橋性樹脂が望ましい。これら樹脂はモールドに利用される樹脂と同一でなくても構わない。塗布方法は様々な手法が適応可能であるが、膜厚の均一性を考慮して例えばスピンコート法が望ましい。

【００１３】高周波スパッタによる成膜前においては、Ａｒをベースとした高周波プラズマ照射で被成膜物の表面をドライエッチングし、外気に触れさせずにそのまま成膜する事が望ましい。また、被成膜物の温度が変化しないように被成膜物を一定温度に保つ事も望ましい。

【００１４】

【実施例】（実施例１：基板裏面にオキシ窒化物ガラス蛍光体を成膜した例１）有機金属化学気相堆積（ＭＯＣＶＤ）法を用いてサファイア基板上にＩＩＩ族窒化物半導体からなるエピタキシャル層を形成した青色ＬＥＤ用エピタキシャルウエハを準備した。エピタキシャル層の積層構造は、一般に公知のＬＥＤ構造とした。このエピタキシャルウエハのサファイア基板裏面にEu^{2+}を添加したＣａ－Ａｌ－Ｓｉ－Ｏ－Ｎ系オキシ窒化物ガラスを以下に示す高周波スパッタリング法で積層した。

【００１５】高周波スパッタリング装置は、チャンバー内底面にターゲットを、チャンバー内天井面にウエハを設置する配置になっている。成膜したい蛍光体と同一濃度、同一組成のEu^{2+}添加Ｃａ－Ａｌ－Ｓｉ－Ｏ－Ｎ系オキシ窒化物ガラスをターゲットとして設置した。高周波スパッタリングチャンバー内を一旦10^{-5}Ｐａ以下に真空引きし、その後Ａｒ１００ｓｃｃｍ（ｓｔａｎｄａｒｄ ｃｃ ｐｅｒ ｍｉｎｕｔｅ）、$O_2$３０ｓｃｃｍ、$N_2$２５ｓｃｃｍを流し圧力を０．５Ｐａに保った。そして成膜時の印加ＲＦパワーを１８００Ｗとして、サファイア基板裏面にEu^{2+}を添加したＣａ－Ａｌ－Ｓｉ－Ｏ－Ｎ系オキシ窒化物ガラスを約２００ｎｍ積層した。

【００１６】この様にして得た白色ＬＥＤ用エピタキシャルウエハを通常の青色ＬＥＤ作製時と同じ工程でチップ化した。図１に本実施例１で作製した白色ＬＥＤの断面図を示す。チップ化された小片は、エピタキシャルウエハ面を下にし電極を兼ねた台座の上に金属にて接着される。電流注入によりＩＩＩ族窒化物半導体の活性層から発光した青色の光はサファイア基板裏面から外部に放出され、一部は蛍光体を励起し黄色から赤色の光に変換され、青色発光と合わさって高出力の白色光が放出され

る。

【００１７】（実施例２：エピタキシャルウエハ表面にオキシ窒化物ガラス蛍光体を成膜した例）実施例１と同様に、ＭＯＣＶＤ法を用いてサファイア基板上にＩＩＩ族窒化物半導体からなるエピタキシャル層を形成した青色ＬＥＤ用エピタキシャルウエハを準備した。このエピタキシャルウエハのエピタキシャル層表面を通常の青色ＬＥＤ素子化工程に従って、ｎ型電極形成面を表出される為のドライエッチング、ｐ型透光性電極の形成、ｐ型電極パッドの形成を実施し、電極アロイングを実施した後、ｐ型電極パッド上とｎ型電極形成面上にはオキシ窒化物ガラスが積層されないようにマスクを形成した。次いでEu^{2+}を添加したＣａ－Ａｌ－Ｓｉ－Ｏ－Ｎ系オキシ窒化物ガラスを実施例１と同様の高周波スパッタリング法で約２００ｎｍエピタキシャル層表面上に積層した。オキシ窒化物ガラスの成膜後は二つの電極上に施したマスクをエッチングで除去した。

【００１８】この様にして得た白色ＬＥＤ用エピタキシャルウエハを通常の青色ＬＥＤ作製時と同じ工程でチップ化した。図２に本実施例２の白色ＬＥＤの断面図を示す。チップ化された小片はエピタキシャルウエハ面を上にし、電極を兼ねた台座の上に固定される。先に作製したチップ上のｐ電極、ｎ電極と電極端子との間はＡｕ線を用いて導通を取る。電流注入によりＩＩＩ窒化物半導体の活性層から発光した青色の光はエピ面上部から外部に放出され、一部は蛍光体を励起し黄色から赤色の光に変換され、青色発光と合わさって高出力の白色光が放出される。

【００１９】（実施例３：基板裏面にオキシ窒化物ガラス蛍光体を成膜した例２）実施例１と同様に、ＭＯＣＶＤ法を用いてサファイア基板上にＩＩＩ族窒化物半導体からなるエピタキシャル層を形成した青色ＬＥＤ用エピタキシャルウエハを準備した。このエピタキシャルウエハのサファイア基板裏面にEu^{2+}を添加したＣａ－Ａｌ－Ｓｉ－Ｏ－Ｎ系オキシ窒化物ガラスを以下の方法で樹脂中に分散させて塗布した。

【００２０】Eu^{2+}を添加したＣａ－Ａｌ－Ｓｉ－Ｏ－Ｎ系オキシ窒化物ガラスを粒径１μｍサイズ程度に粉砕し、このガラス粉をアクリル酸樹脂の粉に混合した。ガラス粉と樹脂粉の体積比率は１０：１程度である。十分混合した後、アクリル酸樹脂用の溶剤を加え更に撹拌する。エピタキシャルウエハを窒化物半導体を積層した面と反対の面、即ちサファイアの面を上にしてスピンコート機の台座に真空チャックで固定する。スピンコート機を回転させ、先に準備した溶剤、樹脂、オキシ窒化ガラス蛍光体の混合物を自転しているサファイア基板上に滴下した。塗布厚を十分均一にした後、スピンコート機からエピタキシャルウエハを取り外し、１６０℃に保持された乾燥機内で溶剤を除去した。

【００２１】この様にしてサファイア基板裏面にオキシ窒化物ガラス蛍光体層を形成して得た白色ＬＥＤ用エピウエハを通常の青色ＬＥＤ作製時と同じ工程でチップ化した。本実施例３の白色ＬＥＤの断面図は図１に同じである。チップ化された小片は、エピタキシャルウエハ面を下にし電極を兼ねた台座の上に金属にて接着される。電流注入によりＩＩＩ－Ｖ窒化物半導体の活性層から発光した青色の光はサファイア基板裏面から外部に放出され、一部は蛍光体を励起し黄色から赤色の光に変換され、青色発光と合わさって高出力の白色光が放出される。

【００２２】

【発明の効果】以上述べたように、青色ＬＥＤの光放出部に、発光中心を添加したオキシ窒化物ガラス蛍光体層を有する構造にする事で、効率の良い高出力の白色発光素子を作製する事が可能となった。この結果、照明用として十分実用にかなう白色発光素子を作製することが可能となり、その産業上の利用価値は多大である。

【図面の簡単な説明】

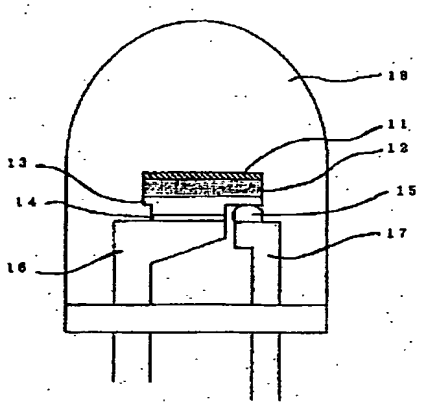
【図１】本発明の実施例１、３に係わる基板裏面にオキシ窒化物ガラス蛍光体層を成膜した白色ＬＥＤの断面構造を示す図

【図２】本発明の実施例２に係わるエピタキシャル層表面にオキシ窒化物ガラス蛍光体層を成膜した白色ＬＥＤの断面構造を示す図

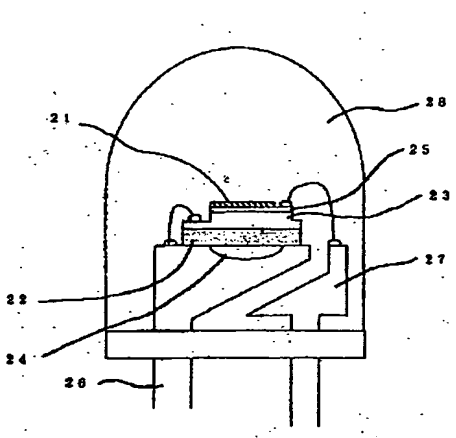
【符号の説明】

１１　オキシ窒化ガラス蛍光体層
１２　サファイア基板
１３　ＩＩＩ窒化物半導体層
１４　電極
１５　電極
１６　マウントリード
１７　インナーリード
１８　樹脂モールド
２１　オキシ窒化ガラス蛍光体層
２２　サファイア基板
２３　ＩＩＩ族窒化物半導体層
２４　光反射鏡
２５　透光性電極
２６　マウントリード
２７　インナーリード
２８　樹脂モールド

【図1】



【図2】



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EE04 EE05 EF01 EG01 FA01
FA10 FB01 FC01 FD01 FE01
FF01 FG01 FH01 FJ01 FK01
FL01 FL02 FL03 GA01 GA10
GB01 GC01 GD01 GE01 HH01
HH03 HH05 HH07 HH08 HH09
HH10 HH11 HH13 HH15 HH17
HH20 JJ01 JJ02 JJ03 JJ05
JJ07 JJ10 KK01 KK03 KK04
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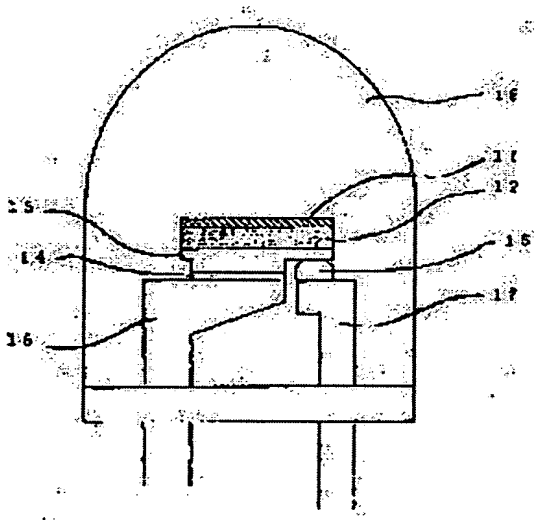
(54) WHITE LIGHT-EMITTING ELEMENT AND MANUFACTURING METHOD THEREOF

(57)Abstract:
PROBLEM TO BE SOLVED: To overcome the problem such that a conventional white LED manufactured by coating a YAG phosphor on a light-emitting surface of a blue LED or dispersing it into a sealing resin is insufficient in brightness to be used for lighting.
SOLUTION: Related to the white light-emitting element, the light emitting part of the blue LED comprising group III nitride semiconductor is provided with an oxynitride glass phosphor layer to which a luminescent center is added. As the oxynitride glass, especially, a Ca-Al-SI-O-N oxynitride glass to which Eu2+ ion is added as the luminescent center is used.



LEGAL STATUS

[Date of request for examination]

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CLAIMS

[Claim(s)]
[Claim 1] In the flip chip mold light emitting device which has the glass fluorescent substance layer which changes a part of light emitted from the light emitting device which consists of an III group nitride semi-conductor formed on the transparent substrate, and a light emitting device into light with wavelength longer than the light to which it is emitted from a light emitting device The white light emitting device characterized by having the oxy-nitride glass fluorescent substance layer which added the emission center on the field of the substrate which is on a transparent substrate and carried out the laminating of the III group nitride semi-conductor at least, and the reverse field.
[Claim 2] The white light emitting device according to claim 1 characterized by oxy-nitride glass being calcium-aluminum-Si-O-N system oxy-nitride glass which added Eu2+ ion as an emission center.
[Claim 3] The manufacture approach of the white light emitting device according to claim 1 or 2 characterized by forming the oxy-nitride glass fluorescent substance layer which added the emission center by the RF spatter.
[Claim 4] The manufacture approach of the white light emitting device according to claim 1 or 2 characterized by forming by spreading of the oxy-nitride glass fluorescent substance which distributed in resin the oxy-nitride glass fluorescent substance layer which added the emission center.
[Claim 5] The white light emitting device characterized by having at least the oxy-nitride glass fluorescent substance layer which added the emission center on the transparent electrode side in the light emitting device which has the glass fluorescent substance layer which changes a part of light emitted from the light emitting device which has a transparent electrode, and a light emitting device on the III group nitride semi-conductor formed on the substrate into light with wavelength longer than the light to which it is emitted from a light emitting device.
[Claim 6] The white light emitting device according to claim 5 characterized by oxy-nitride glass being calcium-aluminum-Si-O-N system oxy-nitride glass which added Eu2+ ion as an emission center.
[Claim 7] The manufacture approach of the white light emitting device according to claim 5 or 6 characterized by forming the oxy-nitride glass fluorescent substance layer which added the emission center by the RF spatter.
[Claim 8] The manufacture approach of the white light emitting device according to claim 5 or 6 characterized by forming by spreading of the oxy-nitride glass fluorescent substance which distributed in resin the oxy-nitride glass fluorescent substance layer which added the emission center.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Especially this invention relates to the white light emitting device which combined the light emitting device using the III group nitride semi-conductor (general formula: AlGaInN) with respect to a white light emitting device and its manufacture approach, and the glass fluorescent substance, and its manufacture approach.
[0002]
[Description of the Prior Art] The fluorescent substance (YAG system fluorescent substance) which doped Ce as white light emitting diode in the YAG system oxide parent grid known for the empirical formula of 3(Y, Gd) (aluminum, Ga)5O12 What [was distributed in the closure resin which surrounds the blue light emitting diode (blue LED) using an III group nitride semi-conductor] (a patent number 2900928, a patent number 2998696, patent number 2927279) What formed membranes on blue LED as a fluorescent substance layer of the shape nature of a non-particle (JP,11-46015,A) is known. These are used for the back light of a display, the illumination type actuation switch, the LED drop, etc.
[0003]
[Problem(s) to be Solved by the Invention] Since blue LED of high brightness using an III group nitride semi-conductor put in practical use, the attempt which is going to use blue LED for white lighting is advanced. However, white LED of brightness which applies a YAG system fluorescent substance to the conventional blue LED chip, and is made was inadequate as an object for lighting. It is because a YAG system fluorescent substance has excitation efficiency worse than 400nm to the light of long wavelength. Incidentally the white for lighting points out all colors currently used for lighting, such as a sunlight color, a fluorescent lamp color, and an electric bulb color. This invention aims at offering the new white light emitting device which combined the light emitting device using an III group nitride semi-conductor which has brightness sufficient as an object for lighting, and the glass fluorescent substance, and its manufacture approach.
[0004]
[Means for Solving the Problem] this invention -- (1) -- with the light emitting device which consists of an III group nitride semi-conductor formed on the transparent substrate In the flip chip mold light emitting device which has the glass fluorescent substance layer which changes a part of light emitted from a light emitting device into light with wavelength longer than the light to which it is emitted from a light emitting device On the field of the substrate which is on a transparent substrate and carried out the laminating of the III group nitride semi-conductor at least, and a reverse field The white light emitting device characterized by having the oxy-nitride glass fluorescent substance layer which added the emission center, (2) -- a white light emitting device given in (1) characterized by oxy-nitride glass being calcium-aluminum-Si-O-N system oxy-nitride glass which added Eu2+ ion as an emission center -- it comes out.
[0005] Moreover, (1) characterized by this invention forming the oxy-nitride glass fluorescent substance layer which added (3) emission centers by the RF spatter or the manufacture approach of a white light emitting device given in (2), (4) -- (1) characterized by forming by spreading of the oxy-nitride glass fluorescent substance which distributed in resin the oxy-

nitride glass fluorescent substance layer which added the emission center, or the manufacture approach of a white light emitting device given in (2) -- it comes out.
[0006] Moreover, the light emitting device which has a transparent electrode on the III group nitride semi-conductor in which this invention was formed on (5) substrates, In the light emitting device which has the glass fluorescent substance layer which changes a part of light emitted from a light emitting device into light with wavelength longer than the light to which it is emitted from a light emitting device The white light emitting device characterized by having at least the oxy-nitride glass fluorescent substance layer which added the emission center on the transparent electrode side, (6) -- a white light emitting device given in (5) characterized by oxy-nitride glass being calcium-aluminum-Si-O-N system oxy-nitride glass which added Eu2+ ion as an emission center -- it comes out.
[0007] Moreover, (5) characterized by this invention forming the oxy-nitride glass fluorescent substance layer which added (7) emission centers by the RF spatter or the manufacture approach of a white light emitting device given in (6), (8) -- (5) characterized by forming by spreading of the oxy-nitride glass fluorescent substance which distributed in resin the oxy-nitride glass fluorescent substance layer which added the emission center, or the manufacture approach of a white light emitting device given in (6) -- it comes out.
[0008]
[Embodiment of the Invention] As a new fluorescent substance ingredient, the fluorescent substance which used oxy-nitride glass as the parent raw material is reported (solid-state physics Vol.35, No.6 (2000)). The peak of an excitation spectrum is 350nm - 500nm, and the fluorescent substance which used oxy-nitride glass as the parent can excite a fluorescent substance most efficiently at blue LED (the core of luminescence wavelength is 450nm - 520nm.) using an III group nitride semi-conductor. Then, this invention person developed the white light emitting device of a well head and high power by combining with blue LED using an III group nitride semi-conductor the fluorescent substance which used oxy-nitride glass as the parent ingredient.
[0009] As oxy-nitride glass, Si-O-N, Mg-Si-O-N, aluminum-Si-O-N, Nd-aluminum-Si-O-N, Y-aluminum-Si-O-N, calcium-aluminum-Si-O-N, Mg-aluminum-Si-O-N, Na-Si-O-N, Systems, such as Na-calcium-Si-O-N, Li-calcium-aluminum-Si-O-N, Na-B-Si-O-N, Na-Ba-B-aluminum-Si-O-N, Ba-aluminum-Si-O-N, Na-B-O-N, Li-P-O-N, and Na-P-O-N, are known.
[0010] Especially as a parent used for this invention in these systems, calcium-aluminum-Si-O-N system oxy-nitride glass is desirable. As a presentation of calcium-aluminum-Si-O-N system oxy-nitride glass, it is desirable that the sum total of five components considers as 100-mol % at CaO:20-50-mol % and 2O3:0.1-30 mol [of aluminum] % and SiO:25-60-mol % and AlN:5-50-mol oxide [% and rare earth] or transition-metals oxide: 0.1-20-mol %. Furthermore, a nitrogen content is less than [15wt%] desirably. It is also desirable to contain as a coactivator with 0.1-10-mol % of a content in fluorescent glass as a sensitizer by using other rare-earth-elements ion as a rare earth oxide.
[0011] The emission center added has especially desirable transition-metals ion, such as rare earth ion, such as Eu2+, Eu3+, Ce3+, and Tb3+, and Cr3+, Mn2+, among these is desirable. [of Eu2+] These emission center ion is incorporated in the solid-state in the form where the calcium2+ ion of a parent ingredient is replaced.
[0012] When producing the oxy-nitride glass fluorescent substance layer which added the emission center for an LED chip, the membrane formation technique of oxy-nitride glass is indispensable. this invention person is applying a RF spatter, and succeeded in making the substrate rear face or epitaxial layer front face of the wafer for blue LED using an III group nitride semi-conductor form the oxy-nitride glass fluorescent substance layer which added the emission center. Applying the object which distributed the powder of an oxy-nitride glass fluorescent substance in resin in addition to a RF spatter can also form membranes. The resin used as a binder has desirable cross-linking resin, such as acrylic-acid (meta) system resin, and epoxy, urethane bridge formation, UV hardening. These resin may not be the same as the resin used for a mould. Although various technique can be adapted, in consideration of the homogeneity of thickness, the spin coat method of the method of application is desirable.

[0013] It is desirable to form membranes as it is, without carrying out dry etching of the front face of the object formed membranes by the high frequency plasma exposure which used Ar as the base before membrane formation by the high frequency spatter, and making the open air touched on. Moreover, it is also desirable to maintain the object formed membranes at constant temperature so that the temperature of the object formed membranes may not change.
[0014]
[Example] (Example 1: Example 1 which formed the oxy-nitride glass fluorescent substance at the substrate rear face) organic metal chemical vapor deposition (MOCVD) -- the epitaxial wafer for blue LED in which the epitaxial layer which consists of an III group nitride semi-conductor was formed on silicon on sapphire was prepared using law. Generally the laminated structure of an epitaxial layer was taken as well-known LED structure. The laminating was carried out by the RF-sputtering method which shows below the calcium-aluminum-Si-O-N system oxy-nitride glass which added Eu2+ at the silicon-on-sapphire rear face of this epitaxial wafer.
[0015] RF-sputtering equipment is the arrangement it install a target in the base in a chamber and installs a wafer in the head-lining side in a chamber. The Eu2+ addition calcium-aluminum-Si-O-N system oxy-nitride glass of the same concentration as a fluorescent substance to form and the same presentation was installed as a target. Vacuum suction of the inside of a RF-sputtering chamber was once carried out to 10 - 5 or less Pa, and the sink pressure was kept for Ar100sccm (standard cc per minute), O230sccm, and N225sccm at 0.5Pa after that. And about 200nm laminating of the calcium-aluminum-Si-O-N system oxy-nitride glass which added Eu2+ at the silicon-on-sapphire rear face was carried out, having used impression RF power at the time of membrane formation as 1800W.
[0016] Thus, the obtained epitaxial wafer for white LED was chip-ized at the same process as the time of the usual blue LED production. The sectional view of white LED produced by this example 1 to drawing 1 is shown. The chip-ized wafer is pasted up with a metal on the plinth which turned the epitaxial wafer side down and served as the electrode. A blue light which emitted light from the barrier layer of an III group nitride semi-conductor by current impregnation is emitted outside from a silicon-on-sapphire rear face, a part excites a fluorescent substance, and is changed into a red light from yellow, it is joined to blue luminescence, and the white light of high power is emitted.
[0017] (Example 2: Example which formed the oxy-nitride glass fluorescent substance on the epitaxial wafer front face) an example 1 -- the same -- MOCVD -- the epitaxial wafer for blue LED in which the epitaxial layer which consists of an III group nitride semi-conductor was formed on silicon on sapphire was prepared using law. After carrying out dry etching to express n mold electrode forming face for the epitaxial layer front face of this epitaxial wafer according to a blue LED component chemically-modified [usual] degree, formation of p mold translucency electrode, and formation of p mold electrode pad and carrying out electrode alloying, on p mold electrode pad and n mold electrode forming face, the mask was formed so that the laminating of the oxy-nitride glass might not be carried out. Subsequently, the laminating of the calcium-aluminum-Si-O-N system oxy-nitride glass which added Eu2+ was carried out on about 200nm epitaxial layer front face by the same RF-sputtering method as an example 1. After membrane formation of oxy-nitride glass removed the mask given on two electrodes by etching.
[0018] Thus, the obtained epitaxial wafer for white LED was chip-ized at the same process as the time of the usual blue LED production. The sectional view of white LED of this example 2 is shown in drawing 2 . The chip-ized wafer turns an epitaxial wafer side up, and is fixed on the plinth which served as the electrode. A flow is taken using Au line between p electrode on the chip produced previously, n electrode, and an electrode terminal. A blue light which emitted light from the barrier layer of an III nitride semi-conductor by current impregnation is emitted outside from the EPI side upper part, a part excites a fluorescent substance, and is changed into a red light from yellow, it is joined to blue luminescence, and the white light of high power is emitted.
[0019] (Example 3: Example 2 which formed the oxy-nitride glass fluorescent substance at the substrate rear face) an example 1 -- the same -- MOCVD -- the epitaxial wafer for blue LED in which the epitaxial layer which consists of an III group nitride semi-conductor was formed on silicon on sapphire was prepared using law. By the following approaches, the silicon-on-sapphire

rear face of this epitaxial wafer was distributed in resin, and the calcium-aluminum-Si-O-N system oxy-nitride glass which added Eu2+ was applied to it.

[0020] The calcium-aluminum-Si-O-N system oxy-nitride glass which added Eu2+ was ground to particle-size size extent of 1 micrometer, and this glass powder was mixed into the powder of acrylic acid resin. The rate of a volume ratio of glass powder and resin powder is about 10:1. After mixing enough, the solvent for acrylic acid resin is added and it stirs further. The field which carried out the laminating of the nitride semi-conductor for the epitaxial wafer, and a reverse field, i.e., the field of sapphire, are turned up, and it fixes to the plinth of a spin coat machine by the vacuum chuck. The spin coat machine was rotated and the mixture of the solvent prepared previously, resin, and an oxy-nitriding glass fluorescent substance was dropped on the silicon on sapphire which rotates. After making coating thickness into homogeneity enough, the epitaxial wafer was removed from the spin coat machine, and the solvent was removed within the dryer held at 160 degrees C.

[0021] Thus, the epiwafer for white LED which formed and obtained the oxy-nitride glass fluorescent substance layer at the silicon-on-sapphire rear face was chip-ized at the same process as the time of the usual blue LED production. The sectional view of white LED of this example 3 is the same as drawing 1 . The chip-ized wafer is pasted up with a metal on the plinth which turned the epitaxial wafer side down and served as the electrode. A blue light which emitted light from the barrier layer of an III-V nitride semi-conductor by current impregnation is emitted outside from a silicon-on-sapphire rear face, a part excites a fluorescent substance, and is changed into a red light from yellow, it is joined to blue luminescence, and the white light of high power is emitted.

[0022]

[Effect of the Invention] As stated above, it became possible to produce the white light emitting device of efficient high power by making it the structure of having the oxy-nitride glass fluorescent substance layer which added the emission center in the light emission section of blue LED. Consequently, it becomes possible to produce the white light emitting device which suits practical use enough as an object for lighting, and the utility value on that industry is great.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing showing the cross-section structure of white LED which formed the oxy-nitride glass fluorescent substance layer at the substrate rear face concerning the examples 1 and 3 of this invention
[Drawing 2] Drawing showing the cross-section structure of white LED which formed the oxy-nitride glass fluorescent substance layer on the epitaxial layer front face concerning the example 2 of this invention
[Description of Notations]
11 Oxy-Nitriding Glass Fluorescent Substance Layer
12 Silicon on Sapphire
13 III Nitride Semi-conductor Layer
14 Electrode
15 Electrode
16 Mounting Lead
17 Inner Lead
18 Resin Mould
21 Oxy-Nitriding Glass Fluorescent Substance Layer
22 Silicon on Sapphire
23 III Group Nitride Semi-conductor Layer
24 Light Reflex Mirror
25 Translucency Electrode
26 Mounting Lead
27 Inner Lead
28 Resin Mould

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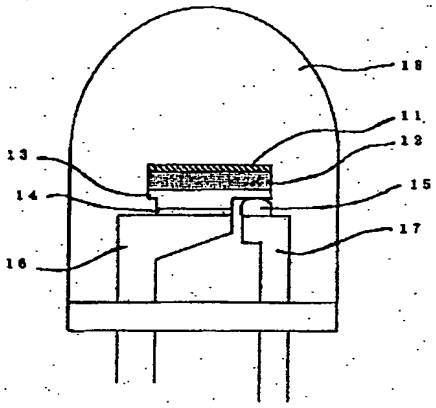
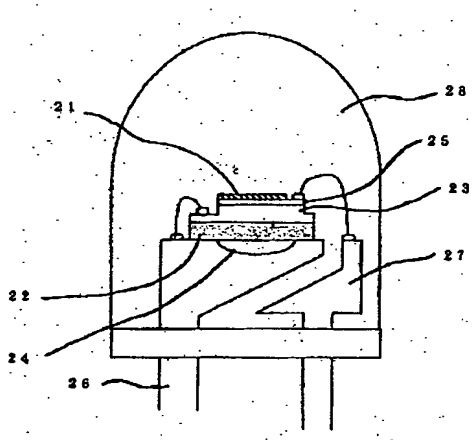
DRAWINGS

[Drawing 1]



[Drawing 2]



[Translation done.]